Indirect Retentionalism: Perceiving Time in an Instant

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We perceive motion, we perceive movement, and we perceive one event succeed another. In ordinary conscious experiences, we seem to *directly* experience many *temporal phenomena* like motion and succession. Although these experiences might initially seem natural and uncontroversial, there is something deeply puzzling in our ability to perceive temporal phenomena. For centuries, philosophers from John Locke (1689) and Thomas Reid (1785) to Franz Brentano (1874), William James (1890), and Edmund Husserl (1928) had been debating the conundrums behind our ability to perceive temporal.

In this paper, I will discuss a particular theory of temporal consciousness proposed by Crick and Koch (Crick & Koch, 2003). In Section I, I will introduce some general issues of temporal consciousness and three major categories of theories – the cinematic, retentional, and extensional. In Section II, I will propose to reinterpret Crick and Koch as retentional realists, instead of cinematic antirealists that philosophers commonly attribute them to be. In Section III, I will isolate Crick and Koch's key idea on retentionalism and characterize this kind of retentionalism, which I term *indirect retentionalism*, against other traditional retentionalist models. In Section IV, I will evaluate the indirect retentionalism and argue that it solves several major challenges of traditional retentionalism without much theoretical sacrifice.

Section I: Issues and Models of Temporal Consciousness

1.1 Issues of Temporal Consciousness

To begin with, not all philosophers agree with the characterization of temporal phenomena in the introduction. Some argue that we do not really experience temporal phenomena. Instead, we either cannot apprehend temporal phenomena like motion, or we somehow infer these phenomena with directly perceiving it. This view is radical, unintuitive, and thus unpopular, and people who hold this view are *phenomeno-temporal anti-realists* (*PT anti-realists* or abbreviate to *anti-realists*). We think we directly perceive motion, but really it is just an illusion, say anti-realists. However, most philosophers agree that we do *directly* experience temporal phenomena like motion and change, and they are called *PT realists* (or abbreviate to *realists*). Realism has a great deal of support from our intuitions since the experience of real motion strikes us so impressively. It's very hard to argue that my seeing the birds flying by or some people walking by in motion is illusory.

Before moving on to discuss the three main types of models for temporal consciousness, it would be helpful to introduce some further issues of temporal consciousness that will help distinguish the three types of models. One issue concerns the relationship between our experiences and the external events. It seems intuitive that our experience temporally matches or *mirrors* the external events in some ways. Lee (2014: 8) formulates three versions of such intuitions. First, the *Metrical Mirroring* claims that the order and duration of external events matches those of our experiences. When I listen to music, if there is a *E* played for 1 second, followed by a *D* played for 1 second, my auditory experience should be exactly *E* for 1 second followed by *D* for 1 second. Both the temporal order and the duration must match up to satisfy

the Metrical Mirroring. Second, a weaker intuition *Topological Mirroring* claims that the temporal order of our experiences matches that of the external events. However, the durations of the experiences do not need to match that of the external events. Third, an even weaker intuition *Structural Mirroring* claims that distinctive stages of the content are represented by distinctive experiential stages. Structural Mirroring requires neither the temporal order nor the durations of our experiences to match those of the external events. It only requires that there is a correspondence between parts of our experiences and parts of the external events. Clearly, Metrical Mirroring implies Topological Mirroring, which then implies Structural Mirroring. If there is a matching of duration and order between our experiences and the external events, then Topological Mirroring is accommodated. Similarly, matching the temporal order between external events and our experiences brings to the idea that different parts of the external events are presented to us by different parts of our experiences. There is also the weakest mirroring intuition that we experience our own experiences *as if* they are temporally extended like the external events. This intuition does not require any properties of our experiences to match those of the external events, except for one property of *appearing* to be temporally extended. Different models of temporal consciousness might capture different levels of the mirroring intuitions.

Another issue is about how the perception of motion and succession compares with the perception of the immediate. As Foster put it, 'duration and change through time seem to be presented to us with the same phenomenal immediacy as homogeneity and variation of colour through space (1982: 255).' This can be put as the *Immediacy Thesis*: change, succession and persistence can feature in our experience with the same vivid immediacy as color or sound, or any other phenomenal feature (Dainton 2017). Note that the Immediacy Thesis entails PT realism. If one commits to the Immediacy Thesis, one thinks that we experience change with the

same phenomenal immediacy (vividness) as we experience color or sound. Therefore, we surly directly experience temporal phenomena, like the way we experience the immediate. And that makes one a PT realist. However, the converse is not true. One can be PT realist without committing to the Immediacy Thesis. The Immediacy Thesis requires the perception of temporal events to as vivid as the perception of the immediate. It is possible that we experience temporal phenomena directly, but these experiences appear to be less vivid (or immediate) than the experiences of the immediate. This would be a strange and unintuitive position to take, but nonetheless a possible one. Different models of temporal consciousness might or might not accommodate the Immediacy Thesis.

Besides the problems concerning the structure of our short or instantaneous episodes of experiences, there are further issues about the structure of experiences over longer intervals. In our ordinary experiences, it seems that we can be *continuously* aware of things for many hours. As James put it, 'consciousness, then, does not appear to itself as chopped up into bits. Such words as "chain" or "train" do not describe it fitly … It is nothing jointed, it flows. A "river" or a "stream" are the metaphors by which it is naturally described (1890: 239).' In other words, our consciousness over longer intervals seems like a continuous 'stream.' But what does it mean for our stream of consciousness to be continuous? One way to understand it is to say that our stream of consciousness is *free of gaps*. When we are awake and conscious, we do not seem to experience something at one time but then have no experience at another time. Instead, we have an experience of some kind at every moment when we are awake and conscious. Moreover, some philosophers think that the continuity of our consciousness involves more than the mere absence of gaps. The continuity also involves a (fairly) high degree of *similarity* of one's experience from moment to moment. Of course, the differences between experiences over long

temporal internals can be significant. But it does seem intuitive that what I experience from moment to moment are very similar to each other with only small differences. The view that our consciousness is continuous since it is free of gaps and/or it has significant degree of moment-to-moment qualitative similarity is called the *Modest Continuity Thesis*.

But some philosophers go a step further beyond the Modest Continuity Thesis. They claim that our moment-to-moment experiences not only are free of gaps and have significant qualitative similarity, but also are *experientially connected*. What being experientially connected means is that neighboring experiences are connected, and this kind of connection itself is also part of our experience. In other words, we also experience the connection between experiences. These philosophers would claim that in the absence of such connections, we do not have a *stream* of consciousness, but merely a sequence of isolated momentary stream-phases. This view is called the *Strong Continuity Thesis*, which additionally requires experiential connectedness beyond what the Modest Continuity Thesis requires. Some other philosophers argue that although consciousness is commonly described as continuous, our consciousness in fact is highly disjointed. This view is called the *Discontinuity Thesis*. Different models of temporal consciousness might commit to different thesis concerning continuity.

1.2 The Classical Models

To deal with the paradox of temporal awareness, philosophers proposed different accounts of temporal consciousness. These accounts generally fall into three categories: cinematic model, retentional model, and extensional model (Dainton 2017). According to cinematic model, our consciousness itself, together with the contents which we are directly aware of, is not temporally extended. Instead, they are instantaneous. Cinematic model says that our immediate experiences

are akin to static, motion-free ‘snapshots’ or ‘still images,’ like single frames of a movie. Our streams of consciousness are composed of successions of these momentary ‘still frames.’

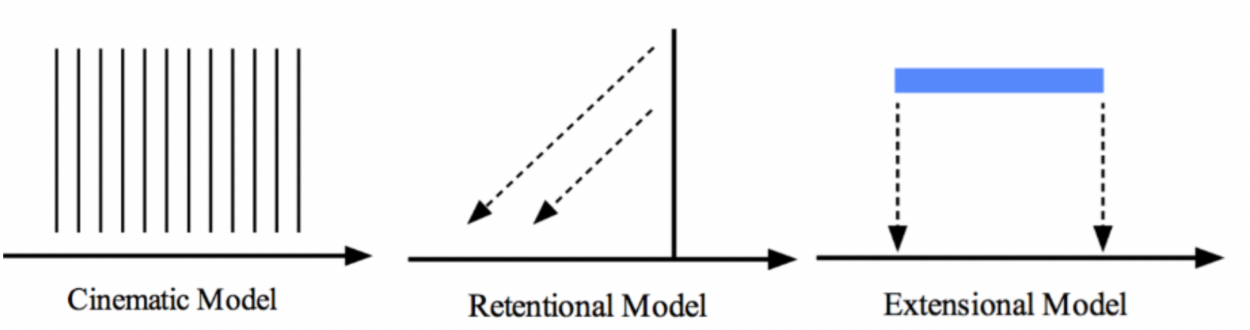


Figure 1. The Three Classical Models of Temporal Consciousness. Adapted from Dainton, B. (2017, June 28). *Temporal Consciousness*. Stanford Encyclopedia of Philosophy.

Cinematic model offers a straightforward answer to the question of how we perceive temporal phenomena. Although our immediate, instantaneous experience is without motion, their occurrence in rapid succession succeeds in generating all the change, succession, and motion that we find in our experience, similar to what happens when we watch a movie. However, there is a notorious problem for the cinematic model that ‘a succession of experiences is not an experience of succession (Dainton 2017).’ The model of temporal consciousness proposed by many cinematic theorists creates only ‘a succession of experiences,’ not ‘an experience of succession.’ This is because that each momentary experience in cinematic models does not experientially connect to another – they are isolated. Therefore, it is very difficult for cinematic model to explain how we experience change or succession. Many cinematic theorists end up giving up realism and claim that we do not perceive motion or other temporal phenomena at all (Dainton 2017).

Retentional model, like cinematic model, says that our consciousness is instantaneous. But unlike cinematic model, it says that the contents of our instantaneous experiences are

temporally extended. In retentional model, our conscious experience contains both the immediate experience as well as some representations (or *retentions*) of the past experiences. Therefore, by virtue of *retaining* the past experiences at present, we manage to experience temporally extended contents in an instance. Our streams of consciousness are composed of successions of these momentary states.

There are generally two kinds of retentional models – *modal* and *non-modal*. The modal retentionalists hold that although the immediate experience and the retentions of past experiences are simultaneously presented, the retentions appear to in the past compared to the immediate experience. In other words, the contents that features simultaneously in our experience appear to be successive and happen at different times. The non-modal retentionalists, on the other hand, hold that all contents, either the immediate or the retentions are experienced as equally present (see Figure 2).

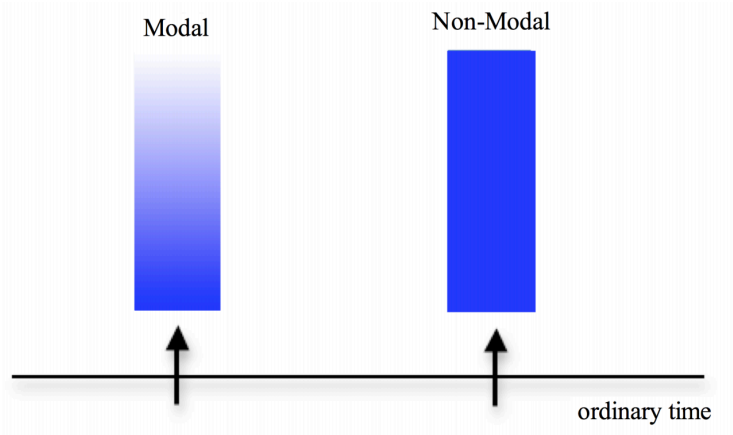


Figure 2. Modal and Non-Modal Retentional Models. From Dainton, B. (2017, June 28). *Temporal Consciousness*. Stanford Encyclopedia of Philosophy.

Unlike cinematic models, retentionalism offers a simple explanation of how an experience of succession differs from a mere succession of experiences. In retentionalist models, successive events are all presented together in an instance. It is by virtue of these events, including both the immediate present and just-past events, being presented together in an instance that we have an experience of succession or change. In addition, retentional model is consistent with the intuition that our consciousness is strictly present and instantaneous. As Reid put it, 'the senses give us information of things only as they exist in the present moment (1785).' Therefore, retentional models, like cinematic models, explain why we have temporal experiences in an instance and, unlike cinematic models, easily get away from the problem of how to generate experiences of succession from succession of experiences. However, retentionalism faces its own set of problems. Notably, there are *the problem of immediacy* and *the problem of retentional simultaneity*, which I will discuss more in section IV.

Extensional model, unlike the cinematic models or the retentional model, say that our consciousness itself is temporally extended. Similar to retentional models, the contents of our experiences in extensional model are temporally extended. Therefore, since both our consciousness and the contents of experiences are spread through time, extensional model explains how we can experience temporal phenomena in a straightforward and natural way. Our streams of consciousness thereby are composed of successions of these extended 'chunks' of experience. For most extensional models, this means that what we experience as present is not strictly instantaneous. Instead, it is a short temporal interval, called *specious present*. The events that fall within a specious present give rise to a continuous experience, which itself spread through ordinary time.

Extensionalism, similar to retentionalism, gives intuitive and satisfying response to how we can perceive temporal phenomena. Unlike retentionalism, extensionalism has the benefit of accommodating all mirroring intuitions easily. Since our consciousness itself is temporally extended in an *isomorphic* way in respect to its contents, all three mirroring intuitions are satisfied. Recall that the strongest intuition Metrical Mirroring claims that the duration and temporal order of our experiences and of the external events match up. Extentionalists can easily accept this, while retentionalists might have to give it up. I will discuss more on this in Section IV.

Section II: Reinterpret Crick and Koch

In a series of papers, scientists Francis Crick and Christof Koch propose their account of temporal consciousness (Crick and Koch 2003a, 2003b, 2004). Philosphers commonly interpret their account as cinematic anti-realist. Notably, Dainton interprets their idea as "according to their 'snapshot hypothesis' (Koch 2003: 122) – *in effect, a version of Cinematic anti-realism* – our consciousness not only comes in discrete chunks, the experience of motion is itself illusory (Dainton 2017, my italic)." In this section, I propose to read Crick and Koch's idea in an alternative and, I will argue, more plausible way. Instead of cinematic antirealism, I propose to interpret Crick and Koch's idea as *retentional realism*.

2.1 Realism or anti-realism?

Let us look at Crick and Koch's ideas more carefully. Here is the passage that Dainton cites to support his interpretation - 'perception might well take place in discrete processing epochs, perceptual moments, frames, or snapshots. Your subjective life could be a ceaseless sequence of such frames … Within one such moment, the perception of brightness, colour, depth and motion would be constant. Think of motion painted onto each snapshot … (Koch 2004: 264).' Based on this and some other passages, Dainton interprets Crick and Koch's model as (1) our perception in discrete and come in chunks, and (2) there is no perception of motion. I agree with the first part. But the second part seems clearly wrong to me.

In The Quest for Consciousness, Koch writes "motion is not experienced because of a change in position between two consecutive snapshots, …, but is represented within a single

snapshot (2004: 264).” In *A Framework of Consciousness*, Crick and Koch say “we propose that conscious awareness (for vision) is a series of *static snapshots, with motion ‘painted’ on them*. By this we mean that perception occurs in discrete epochs … a particular motion can be represented by a constant rate of firing of the relavant neurons … the brain is poor at recognizing accelaration even though it is good at distinguishing movements, as perceived motion is constant during a snapshots, which suggests that there is little or no explicit representation of such change (2003b: 122, my italic).” In addition, they also talk about ‘the snapshot hypothesis proposes that conscious perception of motion is not represented by the change of firing rate of the relevant neurons, but by the (near) constant firing of certain neurons that represent the motion (2003a: 122).’ These passages, together with the passage that Dainton cites, clearly suggests that Crick and Koch think that we can perceive motion. First, they believe that our brains represent movements in some ways, since they think that motion can be represented by neural firing and that our brain is good at recognizing movements. Second, they directly use the term ‘perceived motion’ multiple times, suggesting that they agree that we can perceive motion. Even the Koch’s passage that Dainton cites - “the *perception of* brightness, colour, depth and *motion* would be constant (Koch 2004: 264)” - explicitly talks about “the perception of motion.” This suggests that they are realists, instead of antirealists.

However, Koch does talk about “the illusion of motion (2004: 264-267),” which seems to suggest that he does not think we can perceive motion. Is he being inconsistent in these passages? I think not. There are two kinds of motion (or change, or movement) that Crick and Koch talk about in these passages. One is the change or movement of the external things in the usual sense, and the other is the change of our perceptual states. When they say that “there is no motion,” they mean that there is no *second-order* motion – there is not change in your perception

of change for a short period of time. As Dainton cites, “the *perception of* brightness, colour, depth and *motion* would be constant (Koch 2004: 264).” Here, they are saying that the perception of motion, color, shape, and so forth remain the same for a short period of time. They are not saying that there is no perception of motion. On the country, they think we can perceive motion. It just that the perception of motion remains the same in a temporal interval. When philosphers confuse these two kinds of motion that Crick and Koch talk about, it’s easy for them to interpret Crick and Koch as anti-realists.

I think the confusion mainly comes from the fact that in these passages, Crick and Koch are arguing that our perception is discrete instead of continuous. When they talk about the ‘snapshot hypothesis,’ they explicitly say that ‘by this we mean that perception occurs in discrete epochs (Crick and Koch 2003: 122).’ In another paper *Is perception discrete or continuous?*, Crick and Koch ask “do we experience the world as a continuous signal or as a discrete sequence of events, like the *snapshots* of a Multimedia Component camera?” and argue that “conscious perception might well be constant within a *snapshot* of variable duration … the visual system represents continuous events as a sequence of discrete perceptual ‘*snapshots’* (2003a: 207-208).” In other words, they are arguing that we perceive the world in discrete episodes (snapshots), each extends over a short period of time. Within each of these temporally extended snapshots, our experience remains the same. Exaggeratedly, it’s like watching a movie with terrible internet connection, and you see each frame for a extended period of time while the next frame is still loading. In these passages, they do not seem to aim for explaining how we perceive temporally extended events, although they indeed implicitely do so.

Dainton interprets Crick and Koch's approach as "to find (or posit) a vector-like feature that durationless contents could possess, and which is also such as to strongly suggest or imply movement, even though no movement is actually present (2018)." I think this clearly shows the confusion I mentioned above. The first part of his interpretation, that they think that a durationless vector can imply movement, seems legit. But the second part, that there is no movement present, confuses the two kinds of motions that I mentioned above. Crick and Koch are saying that the perception is discrete and there is no change in perception in a snapshot. Dainton and many other philosophers seem to confuse these two kinds of motion that Crick and Koch talk about and thus interpret Crick and Koch as anti-realists.

2.1 Cinematic, Retentional, or Extensional?

Then if Crick and Koch think that we can perceive motion, what is their account for *how* we can perceive motion? Is their model cinematic as Dainton interprets it to be? Or is it extensional? I think it is neither cinematic nor extentional. According to their 'snapshot hypothesis,' "conscious awareness (for vision) is a series of *static snapshots, with motion 'painted' on them* (2003b: 122)." First note that each of these snapshots are a temporally extended interval. A snapshot is static by virtue of all instantaneous moments in this snapshot are identical (or nearly identical). But what does it mean for motion to be 'painted on static snapshots?' Dainton interprets this as "(an instance in a snapshot is) a vector-like feature that durationless contents could possess, and which is also such as to strongly suggest or imply movement, even though no movement is actually present (2017)." I, on the other hand, propose to interprest their idea as the following: an instance in a snapshot is vector-like feature that durationless contents could possess, which

combines the representation of the immediate (like shape, color, brightness, and so forth) and the representation of motion. And this combined representation corresponds to the direct perception of both the immediate and the motion at every moment in this snapshot. And the perception remains the same during the entire snapshot. My interpretation differs from Dainton's in two major ways. First, in my interpretation, an instance of a snapshot directly represents movement, while in Dainton's, it does not. Second, the representation of motion corresponds to the perception of motion in my interpretation, while in Dainton's, since there is no representation of movement, there is no perception of movement.

According to my interpretation, the 'snapshot' that Crick and Koch talk about is very different from the one Dainton talks about and, more generally, the one that cinematic models commonly talk about. Dainton clearly understands Crick and Koch's 'snapshot' as the latter. First, the 'snapshot' in Crick and Koch's model is temporally extended, while the 'snapshot' in the cinematic model is not. Second, even when we compare an instance of a 'snapshot' in Crick and Koch's model with the 'snapshot' in the cinematic model, (an instance of) the 'snapshot' in the former model directly contains motion representation, while the latter 'snapshot' does not. The 'snapshots' in cinematic model do not contain movement representation – it only *suggests* or *implies* that there is motion. Think about a clearly shot photo versus a blurred photo. A clearly shot photo contains only information of an instance (ignoring the short exposure time). Although it may *suggest,* or even *strongly suggest*, that there is motion, like a photo of soccer player kicking a ball, it does not actually contain movement information (see Figure 3a). On the other hand, a blurred photo literally contains movement information that spans over a short period of time (think about a long-exposure photo, see Figure 3b). A smart algorithm, supposedly, can

reconstruct several frames of images from a single blurred photo with long exposure, since all information across a short period of time is contained in one single blurrled photo.

(a) (b)

Figure 3. (a) Still photo, which corresponds to the 'snapshot' in cinematic model. (b) Blurred photo, which corresponds to an instance in a 'snapshot' in Crick and Koch's model.

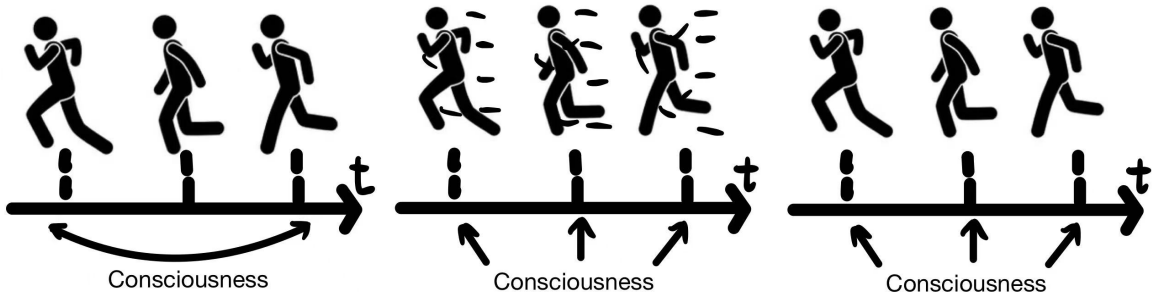
According to my interpretation, Crick and Koch should not be regarded as cinematist. This is because the content of the our experience includes motion, which is essentionally temporally extended. Therefore, by virtue of the content of the our experience being temporally extended, Crick and Koch's model is not cinematic.

I think my interpretation is a more plausible than Dainton's. First, Crick and Koch think that "the mechanism for position-estimation and for detecting motion are largely separate, and a particular motion can be represented by a constant rate of firing of the relavant neurons (2003: 122)." Since there are distinct neural mechanisms for the immediate and the motion, it's natural to say that there are separate representations for them. Second, as argued above, Crick and Koch think that we can perceive motion. And obviously, they think that we can perceive the immediate (like color). Since we can perceive both the immediate and the motion, and our brain represent

both the immediate and the motion, it's natural to say that these representations correspond to these perceptions.

Then is their model extensional? After all, similar to extensional models, Crick and Koch's model divide our experiences into temporally extended 'chunks' (or 'snapshots'). I think Crick and Koch's model is not extensionalist for the following reasons. First, their model says that we perceive the same content in a short period of time. This is different from extensional models where, although experiences are also divided into chunks, the contents within a chunk are different from instance to instance (Dainton 2017; Lee 2014). Second, more importantly, their model says that the temporally extended content , like motion, can be experienced in each one of the instances within one snapshot. In Crick and Koch's model, we experience temporally extended events not by virtue of our consciousness itself being temporally extended, but by virtue of we representing temporally extended content in an instance. It's just Crick and Koch happen to also think that our perception is discrete and thus experiences should be divided into chunks. Therefore, I think Crick and Koch are not extensionalists. Instead, their model can be plausibly interpreted as a *retentional* model by virtue of (1) the content of the our experience being temporally extended and (2) our experience itself is instantaneous.

To better illustrate the differences, let us follow on the previous analogy of photos. Conscious perception in extensionalist model is like live photos, which are basically short videos. Our streams of consciuosness in extensionalist model consist of a series of live photos/short videos (Figure 4a). In cinematic model, our streams of consciuosness are a series of still images, each do not contain any movement information (Figure 4b). In Crick and Koch's model, our streams of consciuosness are a series of blurred images. But the same blurred image would repeat several times over a short period of time (Figure 4c).



(a) (b) (c)

Figure 4. (a) Extensional Model. (b) Crick and Koch's Indirect Retentionalism. (c) Cinematic Model.

In short, I think it is more plausible to interpret Crick and Koch as retentional realists, instead of cinematic antirealists.

Section III: Indirect Retentionalism

As shown in the previous section, Crick and Koch has a whole package of ideas on conscious perception. Some lead to confusions, and some blur their key insights on retentionalism. In this section, I will separate their key insights on retentionalism from their package of ideas and character this kind of retentionalism against other traditional retentionalist models.

I think the key idea of Crick and Koch's version of retentionalism is that our present experience retains past experiences in an *indirect* way, specifically through representing the motion, change, and succession. In traditional retentionalist models, our present experience consists of the experience of the immediate and direct retention of past experiences. However, in Crick and Koch's model, our consciousness does not directly retain or represent past experiences. Instead, it retains the past by virtue of representing the motion or movement. Therefore, I introduce the term *indirect retentionalism* to describe this kind of retentionalism. Indirect retentionalists, like other retentionalists, think that our consciousness is instantaneous, but the content of our experience is temporally extended. Importantly, they think that the content of our experience is temporally extended not by directly retaining past experiences, but by representing motion, movement, succession, and so forth and thus retaining the past indirectly. It is by virtue of representing motion, movement, and succession in an instance that we are capable of experiencing these temporal phenomena.

It might be helpful to introduce a toy model to illustrate the difference between traditional retentionalism and indirect retentionalism. Here, let us assume time is discrete, and the experiences at each temporal instance can be labeled as $e_0, e_1, e_2, \ldots$. And the experience of the immediate (not including temporally extended contents) at each temporal instance can be labeled as $i_0, i_1, i_2, \ldots$. In a toy traditional retentionalist model, let the present experience be $e_t =$

$[i_t, i_{t-1}]$, where i_t is the experience of the immediate at present t and i_{t-1} is the experience of the immediate at the previous temporal instance $t-1$. In a toy indirect retentionalist model, let the present experience be $e_t = [i_t, \delta]$, where i_t is the experience of the immediate at present t and δ is the representation of motion. In a naïve model, let $\delta = i_t - i_{t-1}$ be the difference between the experience of immediate at the previous temporal instance $t-1$ and the experience of the immediate at present t. Both models have temporally extended context at time t – one by directly retaining the past experience i_{t-1}, the other by indirectly retaining the past experience through motion δ. Note that in our toy models, essentially, both models contain exactly the same information. Since $\delta = i_t - i_{t-1}$, we have $i_{t-1} = i_t - \delta$. Therefore, we can get the representation of traditional retentionalist model $[i_t, i_{t-1}]$ from the representation of the indirect retentionalist model - $[i_t, i_t - \delta]$. It's simply that they represent this information in different ways. Of course, it is just a special case that happens in our toy setups, but an enlightening one. Retentionalists can think about more complex ways of retaining the past information beyond directly retaining past experiences. A change in the way of representing the past, even though all information is the same, can solve some serious problems faced by retentionalists, which I will show in Section IV.

Now that we have characterized indirect retentionalism, let us look at some of Crick and Koch's ideas that are not essential to indirect retentionalism. In other words, these are what Crick and Koch commit to that other indirect retentionalists don't have to commit to. First, indirect retentionalism is neutral to the problem of whether the perception is continuous or discrete. Crick and Koch argue that our perception is discrete, but it is not essential to indirect retentionalism. Indirect retentionalists can believe that our perception is continuous. There is nothing

inconsistent about retaining the past through representing movement and the perception being continuous.

Second, indirect retentionalism is neutral to whether the retention is modal or non-modal. Crick and Koch's model seems to be non-modal. And their model is non-modal in two senses. For one thing, Koch holds that "a key property of discrete processing periods is that events that fall within one bin would be treated as simultaneous (2004: 265)." In other words, Koch thinks that all events within the temporal interval of a snapshot are experienced non-modally – all of them will be represented and thus experienced as equally present. For another, in Crick and Koch's model, although the immediate and the motion are represented separately, they are experienced as equally present. Neither of the above two points are necessary to indirect retentionalism. Indirect retentionalists can reject that we experience events that fall within a temporal interval as simultaneous, which makes more sense if one believes that perception is continuous. They can also reject that the immediate and the motion are experienced as equally present. It's possible for indirect retentionalists to hold that the motion is experienced as 'more past' or 'more present' than the immediate, though it might seem unintuitive.

Third, indirect retentionalism is neutral to whether the (visual) experience is atomic or non-atomic. According to Lee (2014), an experience is *atomic* if it does not have experiences as proper parts. In other words, you cannot divide an atomic experience into sub-experiences. An example of non-atomic experience might be the combination of experiences from multiple senses. When I watch a movie, I see the moving pictures, I hear the soundtrack, and I feel the cold air in the movie theater. My whole experience seemingly can be divided into sub-experiences of each sense. Not everyone agrees that this experience is atomic, but it will suffice as an example. Crick and Koch seem to commit to (visual) experiences being non-atomic, since

the representation of the immediate and the representation of motion are separate. It would natural for them to say that our (visual) experience can be divided into sub-experience of the immediate and the sub-experience of motion. But indirect retentionalists don't have to say that. If one think that the representation of the immediate and the representation of motion are intergraded together and are essentially intertwined, for example, because there's one single neural mechanism to represent both, it's more natural to think that our visual experience is atomic.

Section IV: Evaluation of Indirect Retentionalism

As I have characterized the indirect retentionalism, I will now evaluate it in this section. Specifically, I will argue that indirect retentionalism can solve two problems that is challenging for traditional retentionalism – *the problem of immediacy* and *the problem of retentional simultaneity*. In addition, I will go through indirect retentionalists' stance on various general issues of temporal consciousness.

As discussed in Section I, the Immediacy Thesis seems intuitive and is something we want to capture. But this is challenging for traditional retentionalism. On the one hand, if one commits to modal traditional retentionalism, since some retentions are represented as 'more past,' it is difficult to see how temporal phenomena like motion, change, and succession can be experienced with the same vivid immediacy as the experiences of the immediate like color or shape. On the other hand, if one goes with the non-modal option, although one naturally saves the immediacy thesis since the retentions and the immediate appear equally present, it leads to the *problem of surplus content*. To illustrate this problem, suppose that we retain past 9 experiences at each temporal instance. Then since experiences from time $t + 1$ to time $t + 9$ all retain experience at time t with the same level of immediacy, the exact same experience (at time t) will be experienced 10 times! This problem is much worse if one thinks that time is continuous, which leads each instantaneous experience to be experienced as present countless times.

For indirect retentionalists, there is an easy way out of this problem. They only need to commit to a version of non-modality, namely that the immediate and the motion are experienced as equally present. This move saves the Immediacy Thesis. But there will not be a problem of

surplus content for non-modal indirect retentionalists. Since according to indirect retentionalism, we do not directly retain the past experiences, the same experience is not generated multiple times. At each temporal instance, the experience of the immediate and the experience of motion are all different from those of previous or upcoming temporal instances. Therefore, indirect retentionalists can accommodate the Immediacy Thesis easily without facing the problem of surplus content. Of course, they don't have to commit to this non-modal condition, as discussed in the previous section. But then they will have to either give up the Immediacy Thesis or accommodate it in a less obvious way.

In addition to the problem of immediacy, indirect retentionalism can naturally get around the retentional simultaneity problem. The retentional simultaneity problem refers to the seemingly conundrum that a collection of contents which occur *simultaneously* can appear *successive*. How can two experiences occur at the same time, but one appears to be more present while the other appears more past? For traditional retentionalists, if one goes with the non-modal option, he needs to explain how simultaneous contents (the immediate and retentions of the past) can appear successive; if one goes with the modal option, he must give up the intuition that these contents appear successive. However, for indirect retentionalists, since the past experiences are not directly retained, and the simultaneous contents includes the immediate and motion, there does not seem to be a simultaneity problem. I do not think there is an intuition that the immediate and motion appear successive. On the country, we have the intuition backing the Immediacy Thesis that they appear equally present. Therefore, the retentional simultaneity problem does not seem to be a problem for indirect retentionalism.

Nonetheless, indirect retentionalists still need to explain how we manage to experience succession. One possible path to go is add another representation for succession, which

corresponds to the direct perception of succession. In this case, we experience the succession, the motion, and the immediate at the same time. Experiencing events in succession and experiencing the succession of events are different. I don't think it makes sense to say that our experience of succession is less present than our experience of the immediate. Therefore, I think indirect retentionalists can get away with simultaneity problem. Whether the perception of succession is (at least principally) the same as the perception of change is still up to debate. But nevertheless, the retentional simultaneity problem does not seem to bother indirect retentionalists.

Now that I have discussed indirect retentionalists' solutions to some challenges for retentionalism, let me turn to some more general issues of temporal consciousness. Concerning the debate of realism and anti-realism, indirect retentionalists can easily and naturally accept realism. As discussed above, indirect retentionalism can easily accommodate the Immediacy Thesis, which implies realism. It is even easier for indirect retentionalists to accept realism than to accept Immediacy Thesis. One does not even have to commit to non-modality. Simply by virtue of representing motion and succession directly at an instance, similar to the way we represent color and shape, indirect retentionalist can claim that we directly experience motion and succession. Therefore, indirect retentionalists naturally seem to be realists.

Concerning the continuity problem, indirect retentionalists might have even more trouble accommodating the Strong Continuity Thesis than traditional retentionalists. In non-modal traditional retentional models, the past experiences are directly retained without any modification. Therefore, there is a serious possibility that these identical experiences can give rise to experiential connection between different phases of our stream of consciousness. Even so, accommodating the Strong Continuity Thesis is already a difficult challenge for traditional retentionalists, as Broad and Husserl struggle to do so (Dainton 2017). Unfortunately, for indirect

retentionalists, since the past experiences are not directly retained, it is even less obvious how moment-to-moment experiences can be experientially connected. But since accommodating the Strong Continuity Thesis is problematic for retentionalists anyways, it does not seem to be a major downside for indirect retentionalism in particular.

In terms of the Modest Continuity Thesis, indirect retentionalists can easily accommodate it as the traditional retentionalists. Just like traditional retentionalists, indirect retentionalists can meet the requirements for Modest Continuity Thesis by stipulating that retentional experience phases form dense, gap-free successions and that these phases are qualitatively similar to neighboring phases. Of course, indirect retentionalists can also commit to the Discontinuity Thesis. Crick and Koch might be an example of it. Although they think that our stream of consciousness is free of gaps, they think that there is an abrupt change between neighboring 'snapshots.' It is not clear how qualitatively similar these neighboring 'snapshots' are. But there is a real possibility that they can stipulate these 'snapshots' to be significantly different, and thus commits to the Discontinuity Thesis. Crick and Koch construct their model mainly based on empirical evidence. But the result of their endeavor can seem rather unintuitive. It would be interesting to investigate whether the empirical evidence which their model is based on can be interpreted in a way that accommodates more of our intuitions on continuity.

Concerning the mirroring intuitions, indirect retentionalists, like all retentionalists, must give up Metrical Mirroring. Metrical Mirroring requires that the duration of our experiences match that of the external events. Since retentionalism claims that our experiences are themselves instantaneous, it is not possible for the duration of our experiences, which is instantaneous, to match that of the external (temporal) events, which is temporally extended. Also similar to other retentionalists, indirect retentionalists seem neutral towards Topological

Mirroring. Retentionalists can agree that the temporal order of the external events is preserved by our experiences without any problem, even though our experiences are instantaneous. Of course, some indirect retentionalists, like Crick and Koch, might give up Topological Mirroring. Since Crick and Koch argue that 'events that fall within one bin would be treated as simultaneous (2004: 265),' their model breaks Topological Mirroring. More radical indirect retentionalists, or retentionalists in general, can give up Structural Mirroring as well, which would be even less intuitive.

In short, I've argued that indirect retentionalism can solve some major challenges of retentionalism without giving up much. Some further refinement of indirect retentionalism is worth pursuing for solving various challenges in temporal consciousness.

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